1-5 The aircraft must be strong and stiff enough to support its own weight and the weight of the occupant. However, the amount of power that can be supplied by a human is small compared to an engine, so minimizing weight is paramount. In addition, the material must be formable so as to optimize the aerodynamics. Therefore, the initial material properties one might consider would be yield strength (σ_y), elastic modulus (E), density (ρ) and formability.

A polymer matrix-fiber reinforced composite may be a good choice. These materials can be optimized to have a high specific strength and stiffness (σ_y/ρ and E/ρ) in the desired directions, and can be manufactured in aerodynamic shapes.

1-6 First off, you would like to minimize weight to reduce the cost of launching the satellite. Secondly, the outer shell must be protective; strong and tough enough to withstand any particles that may impact the satellite while in space. Thirdly, the shell must protect the electronics from solar heating and be transparent to radio signals. Therefore material properties to consider would be density (ρ), yield strength (σ_y), toughness, index of refraction and electrical conductivity.

It is difficult to choose one material that possesses all of these qualities. The satellite shell would likely be a composite structure, with a reflective outer surface to minimize solar heating. A strong and tough inner shell is required; however, the need for radio signal transparency limits the use of metallic materials. A nonconductive polymer matrix composite could be used that would also minimize weight.

1-12 The most practical means of material sorting would be based on density (steel is the highest, polymers the lowest). But theoretically one could sort the materials based on electrical or thermal conductivity (aluminum is highest, and polymers the lowest).

1-13 Benefits that each material can provide:
SiC: Very hard, strong and wear resistant, maintains strength at high temperatures.
Al: Provides ductile matrix for brittle SiC particles, high thermal conductivity to minimize local temperatures.

Composites attempt to exploit the best properties of each material (above). However, because the two materials are different, compatibility issues can arise during manufacture (and use) of the composite. One possible problem may involve how well the SiC particles will bond to the Al matrix. If load cannot be shed from the particles to the matrix through the matrix/particle interface, the ductile properties of the Al cannot be exploited. In addition, the coefficients of thermal expansion for the two materials are very different. Upon heating, stresses will likely build up at the particle/matrix interface, possibly debonding the SiC particles. In terms of manufacturing, it will be important to have a homogenous distribution of SiC particles within the Al matrix, which may require special manufacturing techniques.